WHAT IS CLAIMED IS:

1. An optical device comprising:

a transparent material layer having a desired curved surface configuration;

a layer including a variable refractive index material having a dielectric constant anisotropy and having a property in which a sign of a difference $\Delta\varepsilon$ in dielectric constant due to the anisotropy is reversed at driving frequencies f1 and f2;

at least two transparent electrodes arranged to sandwich said transparent material layer and said layer including said variable refractive index material; and

a driving device supplying a voltage including said driving frequencies f1 and f2 between said transparent electrodes.

2. An optical device as set forth in claim 1, wherein said driving device sequentially applies voltages V1 to VN having primary frequencies f1 to fN ($N \geq 2$) to said transparent electrodes for a predetermined period of time and at a predetermined interval.

3. An optical device as set forth in claim 2, wherein when sequentially applying voltages V1 to VN having primary frequencies f1 to fN (N ≥ 2) to said transparent electrodes for a predetermined period of time and at a predetermined interval, said driving device temporarily suspends the supply of the voltage at a desired phase of said interval and subsequently resume the supply of the voltage.

4. An optical device as set forth in claim 1, wherein a dual-frequency liquid crystal is employed as said variable refractive index material having the refractive index anisotropy and the dielectric constant anisotropy and having a difference $\Delta\varepsilon$ of the different dielectric constant which is reversed at the driving frequencies f1 and f2.

5. An optical device as set forth in claim 4, wherein a material having a low wettability with the liquid crystal is arranged at least one of positions contacting said layer of the liquid crystal.

6. An optical device as set forth in claim 4, wherein an alignment layer for aligning the liquid crystal in one direction is provided at the surface of said transparent electrode on the side of the

layer including the variable refractive index material.

7. An optical device as set forth in claim 6, wherein a light is incident to a surface of said layer including the variable refractive index material having a more uniform alignment.

8. An optical device comprising a plurality of optical devices defined in claim 6, said plurality of optical devices being arranged in series so that the ordering directions of the respective alignment layers are perpendicular to each other.

9. An optical device as set forth in claim 1, wherein said two transparent electrodes are substantially parallel transparent electrodes.

10. An optical device as set forth in claim 1, wherein the surface configuration of the transparent material layer on the side of said layer of the variable refractive index material is a convex lens, a concave lens, a fresnel lens, a prism array, a lens array, a lenticular lens or a diffraction grating, or a curved surface formed by a combination thereof.

11. An optical device as set forth in claim 1, wherein one of said transparent electrodes is replaced with an electrode reflecting at least a part of a light incident to said one of said transparent electrodes.

12. An optical device comprising:

a layer including a variable refractive index material having dielectric constant anisotropy and having a property to reverse signs of a difference of dielectric constant $\Delta\varepsilon$ due to anisotropy at driving frequencies f1 and f2;

at least two transparent electrodes arranged to sandwich said layer including said variable refractive index material; and

a driving device applying a voltage, in which voltages from V1 to VN respectively having respective primary frequencies f1 to fN ($N \geq 2$) are superimposed, between said transparent electrodes.

13. An optical device as set forth in claim 12, wherein a transparent material layer having desired curved surface configuration is disposed between said at least two transparent electrodes and adjacent said layer including said variable refractive index material.

14. An optical device as set forth in claim 13, wherein one of said transparent electrodes is replaced with an electrode reflecting at least a part of a light incident to said one of said transparent electrodes.

15. An optical device as set forth in claim 12, wherein when applying a voltage in which voltages V1 to VN having respective primary frequencies f1 to fN ($N \geq 2$) are superimposed, said driving device temporarily suspends the supply of the voltage at a desired timing and subsequently resume the supply of the voltage.

16. An optical device as set forth in claim 12, wherein a dual-frequency liquid crystal is employed as said variable refractive index material having the refractive index anisotropy and the dielectric constant anisotropy and having a difference $\Delta\varepsilon$ of the different dielectric constant which is reversed at the driving frequencies f1 and f2.

17. An optical device as set forth in claim 16, wherein a material having a low wettability with the liquid crystal is arranged at least one of positions contacting said layer of the liquid crystal.

18. An optical device as set forth in claim 16, wherein an alignment layer for aligning the liquid crystal in one direction is provided on the surface of said transparent electrode on the side of the layer including the variable refractive index material.

19. An optical device as set forth in claim 18, wherein a light is incident to a surface of said layer including the variable refractive index material having a more uniform alignment.

20. An optical device comprising a plurality of optical devices defined in claim 18, said plurality of optical devices being arranged in series so that the ordering directions of the respective alignment layers are perpendicular to each other.

21. An optical device as set forth in claim 12, wherein said two transparent electrodes are substantially parallel transparent electrodes.

22. An optical device as set forth in claim 12, wherein the surface configuration of the transparent material layer on the side of said layer of the

variable refractive index material is a convex lens, a concave lens, a fresnel lens, a prism array, a lens array, a lenticular lens or a diffraction grating, or a curved surface formed by a combination thereof.

23. An optical device comprising:

a layer of transparent material having a desired curved surface configuration;

a layer including a variable refractive index material having a positive or negative dielectric constant anisotropy;

at least two transparent electrodes arranged to sandwich said layer of the transparent material and said layer including the variable refractive index material; and

a driving device for always supplying a voltage substantially equal to or greater than an amplitude of a voltage establishing static and vertical alignment in said variable refractive index material.

24. An optical device as set forth in claim 23, wherein said voltage from said driving device is an AC voltage having a primary frequency in a range of 1 Hz to 100 Hz.

25. An optical device as set forth in claim 23, wherein said variable refractive index material is nematic liquid crystal.

26. An optical device as set forth in claim 23, wherein said at least two transparent electrodes are substantially in parallel.

27. An optical device as set forth in claim 23, wherein the surface configuration of the transparent material layer on the side of said layer of the variable refractive index material is a convex lens, a concave lens, a fresnel lens, a prism array, a lens array, a lenticular lens or a diffraction grating, or a curved surface formed by a combination thereof.

28. An optical device as set forth in claim 23, wherein an alignment layer for aligning the liquid crystal in one direction is provided on the surface of said transparent electrode on the side of the layer including the variable refractive index material.

29. An optical device comprising a plurality of optical devices defined in claim 28, said plurality

of optical devices being arranged in series so that the ordering directions of the respective alignment layers are perpendicular to each other.

30. An optical device as set forth in claim 23, wherein a light is incident to a surface of said layer including the variable refractive index material having a more uniform alignment.

31. An optical device as set forth in claim 23, wherein one of said transparent electrodes is replaced with an electrode reflecting at least a part of a light incident to said one of said transparent electrodes.

32. A three-dimensional display device for forming three dimensional image from two-dimensional image on a display portion, comprising:

a layer of a transparent material having a desired curved surface configuration;

a layer of a variable refractive index material having a refractive index varying in accordance with a voltage applied thereto;

at least two transparent electrodes arranged to sandwich said layer of the transparent material and

said layer including the variable refractive index material;

an imaging position shifting portion for shifting an imaging position of said two-dimensional image displayed on said display portion;

a synchronizing portion for synchronizing an updating period of the two dimensional image displayed on said display portion with a shifting period of the imaging point of said imaging position shifting portion; and

a driving portion for driving said imaging point shifting portion by applying a voltage to said at least two transparent electrodes in accordance with an output from said synchronizing portion.

33. A three-dimensional display device as set forth in claim 32, wherein said variable refractive index material of said imaging point shifting portion is liquid crystal.

34. A three-dimensional display device as set forth in claim 33, wherein a material having a low wettability with the liquid crystal is arranged at least one of positions contacting said layer of the liquid crystal of said imaging point shifting portion.

35. A three-dimensional display device comprising a plurality of optical devices defined in claim 34, said plurality of optical devices being arranged in series so that the ordering directions of the respective alignment layers are perpendicular to each other.

36. A three-dimensional display device as set forth in claim 33, wherein an alignment layer for aligning the liquid crystal in one direction is provided on the surface of said transparent electrode on the side of the layer including the variable refractive index material of said imaging point shifting portion.

37. A three-dimensional display device as set forth in claim 36, wherein a light is incident to a surface of said layer including the variable refractive index material having a more uniform alignment.

38. A three-dimensional display device as set forth in claim 32, wherein said two transparent electrodes are substantially in parallel.

39. A three-dimensional display device as set forth in claim 32, wherein said display portion displays depth sampling images formed by decomposing a three-dimensional image into two-dimensional images between planes set at a predetermined interval in a depth direction of an image pick-up position, or depicts a line drawing.

40. A driving method of driving a three-dimensional display device including a display portion for displaying two-dimensional images, an imaging point shifting portion disposed between said display portion and an observer, a synchronizing portion for synchronizing an updating period of the two-dimensional images displayed on said display portion with a shifting period of the imaging point of said imaging point shifting portion, and a driving portion for driving said imaging point shifting portion, said a driving method comprising the steps of:

outputting a plurality of driving signals of an output voltage VN ($N \geq 2$) having frequency fN as a primary frequency for a predetermined period of time assigned to each of the driving signals in a predetermined sequence to drive said imaging point shifting portion in said driving portion; and

updating and displaying said two-dimensional images in a predetermined sequence on said display portion in said synchronizing portion.

41. A driving method of driving a three-dimensional display device including a display portion for displaying two-dimensional images, an imaging point shifting portion disposed between said display portion and an observer, a synchronizing portion for synchronizing an updating period of the two-dimensional images displayed on said display portion with a shifting period of the imaging point of said imaging point shifting portion, and a driving portion for driving said imaging point shifting portion, said a driving method comprising the steps of:

in said driving portion:

generating a driving signal of a predetermined output voltage in which a frequency fN ($N \geq 2$) is superimposed;

applying said driving signal to said imaging position shifting portion;

varying said output voltage in a predetermined sequence in accordance with a synchronization signal of said synchronizing portion; and

in said synchronization portion:

outputting a synchronization signal in said synchronization portion when updating two-dimensional images to be displayed on said display portion.

42. A driving method as set forth in claim 40, further comprising a step of stopping said driving signal for driving said imaging point shifting portion driving a predetermined time duration.

43. A driving method as set forth in claim 41, further comprising a step of stopping said driving signal for driving said imaging point shifting portion driving a predetermined time duration.

44. A three-dimensional display device comprising:

a phantom three-dimensional display device for displaying a phantom three-dimensional image; and

a shutter device formed by a shutter element for controlling a light transmittance, said shutter device being located at a position where said phantom three-dimensional image is reproduced or a position optically equivalent to said position.

45. A three-dimensional display device as set forth in claim 44, wherein said shutter element is two-

dimensionally divided, and each of divided regions are driven independently of the other.

46. A three-dimensional display device as set forth in claim 44, wherein said shutter element lowers a light transmittance in the region of depth sampling images as two-dimensional images of said phantom image at said shutter element position during a time duration that said phantom three-dimensional image is being reproduced on the other side of said shutter element as viewed from the observer.

47. A three-dimensional display device as set forth in claim 44, wherein the material of said shutter element is one or combination of guest-host type liquid crystal containing diachronic dye having a different light beam absorption depending upon an orientation of molecules and liquid crystal having dielectric constant anisotropy, polymer dispersion type liquid crystal containing droplet-like liquid crystal in polymer, polymer dispersed liquid crystal containing a polymer network in liquid crystal, a holographic polymer dispersed liquid crystal having a layer structure of polymer dispersed liquid crystal containing droplet like liquid crystal in polymer and polymer, a holographic polymer dispersed

liquid crystal having a layer structure of said polymer dispersed liquid crystal containing a polymer network in the liquid crystal and polymer, and a polymer dispersed liquid crystal wherein said liquid crystal in said polymer dispersed liquid crystal is said guest-host type liquid crystal.

48. A three-dimensional display device as set forth in claim 44, wherein said phantom three-dimensional display device is constructed with a two-dimensional image display device and a varifocal optical device.

49. A three-dimensional display device comprising:

a phantom three-dimensional display device for displaying a phantom three-dimensional image; and

a shutter device formed by a shutter element for controlling a light transmittance,

said phantom three-dimensional image being a real image, and said shutter element being a photoreactive element for lowering a light transmittance in a real image region at the position of said shutter element in accordance with an imaging light beam of said real image.

50. A three-dimensional display device as set forth in claim 49, wherein a material of said

photoreactive element is one of a photochromic material, a material consisting of a material causing a photostructural change and liquid crystal, and a material having a nematic-anisotropic phase transition temperature to be varied by photostructural change.

51. A three-dimensional display device as set forth in claim 49, wherein said phantom three-dimensional display device includes a two-dimensional image display device and a varifocal optical device.

52. A head-mount display device comprising:

two display devices corresponding to left and right eyes and each including a two-dimensional display device and an optical device having a variable focal length; and

a control device for controlling said two dimensional display device and said optical device having a variable focal length,

said display devices being mounted to left and right eyes, and said control device synchronously driving said two-dimensional display device and said optical device to perform three-dimensional display.

53. A head-mount display device as set forth in claim 52, wherein said optical device further comprises a deflection device for varying a direction of a light incident to said optical device, and said control device controls said optical device in such a way that when the image is moving closer to the eyes according to a change of the focal length, the overall display image of said two-dimensional display device is deflected to be closer toward the center between the left and right eyes.

54. A head-mount display device as set forth in claim 52, wherein said optical device has a transparent material of one of forms of a fixed focus lens shape, a fixed prism shape, and a shape where the fixed deflection mechanism is incorporated into the fixed focus lens or a combination thereof, a layer including a variable refractive index material, and at least a pair of transparent electrodes for sandwiching said layer.

55. A head-mount display device as set forth in claim 54, wherein said variable refractive index material is liquid crystal having dielectric constant anisotropy and refractive index anisotropy.

56. A head-mount display device as set forth in claim 55, wherein said variable refractive index material is liquid crystal having dielectric constant anisotropy and refractive index anisotropy, and being dual-frequency liquid crystal having a different physical property having a different sign of a difference in a dielectric constant corresponding to orientation of the liquid crystal molecules between different frequencies f1 and f2.

57. A head-mount display device as set forth in claim 54, wherein said variable refractive index material is polymer dispersed liquid crystal, and the droplet size of the liquid crystal or the droplet size of the polymer is smaller than a wavelength of visible light.

58. A head-mount display device as set forth in claim 54, wherein said fixed focus lens is spherical or non-spherical single lens or fresnel lens.

59. A head-mount display device as set forth in claim 54, wherein said fixed prism is simple prism or a multi-prism having an array of a plurality of fine prisms.

60. A head-mount display device as set forth in claim 54, the form where said fixed deflection mechanism is incorporated in to said fixed focus lens is in the form of increasing or decreasing an angle formed by a spherical or non-spherical simple lens or a fresnel lens and an optical axis.

61. A head-mount display device as set forth in claim 52, wherein said driving device sequentially applies voltages V1 to VN having primary frequencies f1 to fN ($N \geq 2$) to said transparent electrodes for a predetermined period of time and at a predetermined interval.